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FOREIGN TECHNOLOGY DIVISION

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FTD -ID(RS)T-0582-78

EDITED TRANSLATION

FTD-ID(RS)T-0582-78 4 May 1978

MICROFICHE NR: FTD-78-C-000620

AERONAUTICAL KNOWLEDGE
(Selected Articles)

English pages: 8

Source: Hang K'ung Chih Shih, No. 8, 1977, pp. 8,11.
Requester: SDSS
Country of origin: China
Translated by: LINGUISTICS SYSTEMS, INC.
F33657-76-D-0389
H. P. Lee

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Table of Contents

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

A Brief Talk on Man-made Earth Satellite Orbit

- The Movement of Satellite Orbit Plane -

Wu Ling-yao

Following the article which describes the movement of a satellite inside the orbit plane, published in last issue of this journal, this article is to describe the movement of the satellite orbit plane.

A plane where a man-made earth satellite orbit is located is called orbit plane. This plane through the center of the earth forms various angles with the terrestrial equatorial plane. These angles are called orbit inclination. When the orbit plane coincides with the equatorial plane, the inclination is zero. And when the orbit plane is perpendicular to the equatorial plane, the inclination is 90°. At this time the satellite will fly over the arctic pole and the antarctic pole, so the orbit of which the inclination is 90°, is also called polar orbit (Figure 1).

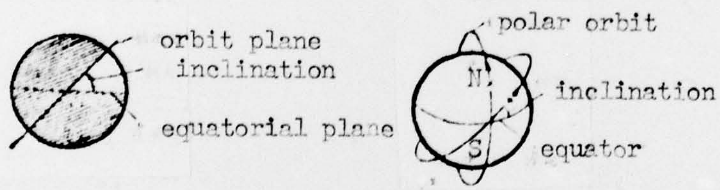
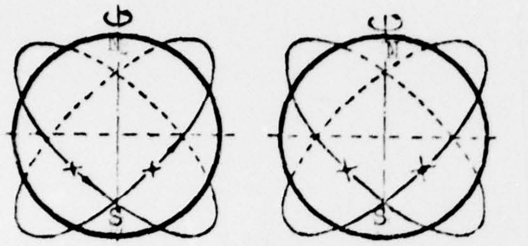


Figure 1

When the inclination is smaller than 90°, the satellite moves from southwest to northeast or from northwest to southeast. Following the direction of the earth rotation, it is called progressive orbit (Figure 2 left). When the inclination becomes larger than 90°, the movement of the satellite is opposite to the direction of the earth rotation, it is called retrograde

orbit (Figure 2 right).



progressive orbit   retrograde orbit

Figure 2

Most of the man-made satellite take progressive orbit because the launching can get some help from the earth rotation. Thus the burden of carrying the satellite can be lessened. Except for the arctic and the antarctic two poles, everything on the earth, because of the earth rotation, has eastward speed. This speed at the equator is 470m per second, that is about 6% of the first cosmic speed, and at the place of latitude 45^{o}, it is 33m per second. If the launching takes a retrograde orbit, this eastward speed will be opposite to the direction of the satellite movement. Consequently, it will be worse than useless. And in order to offset such counteraction, it must use much more energy to move the satellite.

Inclination is a very important characteristic of satellite orbit. When the inclination is small, the rate of using eastward speed will be high, so the launching will be easier and consume less energy, but the areas from where the satellite can be seen on the earth will be limited. If the inclination is large, the areas on the earth from where the satellite can be seen will be large, but the launching of the satellite will consume more energy. In order to have a large area on the earth from where the satellite can be seen or in order to let the satellite see a larger part of the surface of the earth, the inclination must be made larger. For

such activities as reconnaissance, navigation, ground survey and natural resources exploration, the satellite always takes an orbit of large inclination or a polar orbit. The inclination of China's first two satellites is large. One is 68.5° and the other is 69.9°. So they are visible at both polar areas, in other words, China's red star satellites could be seen by everyone from everywhere on the earth.

The Directionality of Orbit Plane

Due to the earth rotation, everything on earth as well as in sky is led to rotate. Only man-made earth satellite can move along its orbit and is free from such effect. The orbit plane of a satellite like a revolving round plate has its own directionality and constantly holds its regular direction. The earth turns 15° every hour, and it will turn 30° eastward in the time when a satellite flies around the earth one time provided that the cycle period of the satellite is 120 minutes. If the surface of the earth the satellite sees when it is being launched is Shanghai, after having made a cycle and returned to its launching point, it is already in the sky over Lhasa of Tibet(Figure 3 illustrates the path of the satellite on earth). In a day, the satellite makes 12 cycles and the earth turns 360°, then the satellite returns back to the sky over Shanghai again. So by making use of the fact that the orbit plane does not move and the earth turns, the satellite can fly from east to west and from south to north around the earth. Opposite to the "moving around" orbit, there is a "stationary" orbit that is the well known earth-synchronous orbit.

***   ***   ***   ***   ***   ***   ***

These are the initial positions of the orbit plane. Following the revolution of the earth and the forward movement of the orbit plane (it is supposed to be a polar orbit, so its forward movement is zero), the orbit plane is gradually getting away from its initial position. But, because of the slow motion of the orbit plane (about 1^{o} a day) in several days or from 1 to 2 weeks, it can be considered no change has happened.

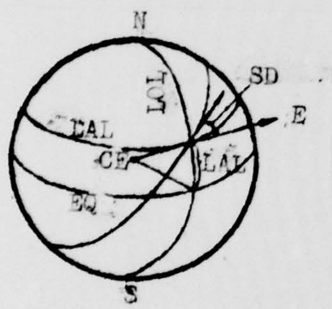
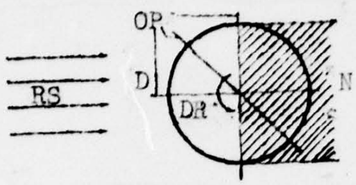


Figure 1

Note: N = north
SD = speed directional angle
LOL = longitude line
E = east
LAL = [illegible]itude line
CE = [illegible] the earth
EQ = equ[illegible]
S = south

It will affect the work of a satellite when the orbit plane is opposing the position of the sun. So in design as well as the launching of a satellite, such a fact must be given serious consideration. As the first orbit mentioned above, the orbit is entirely exposed to the sun when it is perpendicular to the position of the sun, and the satellite in a whole round of the orbit will be illuminated by the sun. This is useful for the solar battery to generate electircity, but it is harmful in temperature control of the satellite as it is continuously heated by the sune for a long period of time. The second kind of orbit is that the altitude of the sun is constantly 45^{o}. It is a good light condition for the satellite to



Note: OP = orbit plane
D = day time
RS = rays of sun
DR = direction of earth rotation
N = night

Figure 11 AA' (A is above), BB' (B is above), CC' (C is above) the intersecting points of perpendicular, inclining and level orbit plane with the earth

survey and to take picture of objects with shadow on the earth. The third orbit is that the time underneath the satellite is noontime and the light is very bright, so the satellite can have clearer pictures of the surface of the earth. But the time for the satellite to pass through the shady arae of the earth constitutes 30-40% of a cycle (intermediate and low orbit). So it must be equipped enough batteries so as to supply electricity to the equipment in the satellite when it is in the shady area.

The Effect of Temperature and Altitude on the Rocket Engine Thrust of a Satellite

Chang Kwang

For the engine of a solid rocket, the higher is the environmental temperature and the working altitude, the greater is the engine thrust. Why so? This article is attempting to find an answer.

Most of the rockets and missiles used by a satellite in the space use the thrust produced by solid rocket engine as power source. The magnitudes of thrust required by the flying crafts are different. The large ones may require several hundred or thousand tons; while the small ones may require only a few kilograms.

The Production of Thrust

Solid rocket engine thrust is a forward-pushing power produced when the solid fuel is burning in the rocket engine. Because the engine is able to produce such power, rockets and missiles and other flying crafts can in the air overcome the impact of air resistance as well as its own weight, and fly in a regular speed to their respective destination.

Now let's talk about the process of how an engine produces thrust. In order to make the engine start to work, it must, first of all, use an ignitor to ignite the solid powder-charge, and the solid powder-charge then begins to combuts in the combustion chamber. The combustion means that the chemical energy contained in the solid powder-charge begins to change into thermal energy and creates combustion air of high temperature.

Then the combustion air is accelerated through inflation in a nozzle, and the thermal energy thereby becomes kinetic energy. Finally a supersonic combustion air stream jets out from the nozzle of an engine. Why can the combustion air continuously and very rapidly increase its flow velocity? This is because the combustion air in the engine receives several different kinds of applied forces. According to the second law of dynamics, the speed of combustion air flow is determined by the amount of applied forces it has received. And according to the thrid law of of dynamics, where there is an applied force, there is a counter force. When the combustion air receives applied force in the engine, it must at the same react against the inner walls of the engine. This counter force is equal to the applied force received by the combustion air in the engine but in an opposite dirextion. The axial composite force of the counter forces is the main component of the engine thrust.

The Effect of Environmental Temperature on Engine Thrust

In a vast territory like China has, the engine used in an aircraft can encounter different environmental temperature in different climate, such as the hotness in the south during summer and the coldness in the north during winter. This environmental temperature ranges from 70° above zero to 50° below zero. Under a condition of no temperature control, the initial temperature (environmental temperature) brought along with the engine powder-charge is different.

Now let's examine what kind of effect of the environmental temperature can have on engine thrust. As has been mentioned above, the chemical

energy of the solid propellant turns into kinetic energy through combustion. And as we all know that when something is about to burn, its temperature must be first increased to the "burning point", so is the situation of the solid propellant. But because of the difference of environmental temperature, the quantity of heat contained in the powder-charge is accordingly different. In order to ignite the powder-charge, it therefore requires to increase the quantity of heat and makes it reach to the "burning point". It takes a certain period of time to transfer the heat needed. If the environmental temperature is low, the heat that needs to be transferred is more and the time it needs is longer. Otherwise, environmental temperature is high, the heat transferred is less and the time it takes is shorter.

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